



FAA-1146b

December 20, 1973

SUPERSEDING

FAA-1146a, 8/1/60 and
Amendment-2, 4/13/66

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION SPECIFICATION

APPROACH LIGHT SUBSTATION POWER AND CONTROL UNIT NO. 1

1. SCOPE

1.1 Scope.- This specification covers the Federal Aviation Administration requirements for a 175 KVA, 2400/4160V, three-phase, four-wire solidly grounded neutral, 60 hertz, power switchgear and control unit, to be used in conjunction with and connected to a 150 KVA constant current regulator unit of either the moving coil (Specification FAA-1147b) or the saturable reactor type (Specification FAA-1148b), to form an integrated substation assembly as shown on Drawing No. D-5205-1. The purpose of the integrated substation is to furnish a source of power and brightness control to 20 ampere series approach light systems, auxiliary station power, and power and controls for condenser discharge sequenced flashing light system.

1.2 Classification.- This power and control unit shall bear the following type designation: TYPE CCRS-3 (Unit No. 1).

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The FAA specifications, standard, and drawings of the issue specified in the invitation for bids or request for proposal form part of this specification. In case of conflict between this specification and reference specifications, this specification shall govern.

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2.1.1 FAA specifications

- FAA-1147b Regulator Substation Unit #2 (Moving Coil Type)
- FAA-1148b Regulator Substation Unit #2 (Saturable Reactor Type)
- FAA-D-2494/1 Instruction Book Manuscripts Technical; Equipment and Systems, Requirements, Part I
- FAA-D-2494/2 Instruction Book Manuscript Technical; Equipment and Systems, Requirements, Part II

2.1.2 FAA standard

- FAA-STD-013 Quality Control Program Requirements

2.1.3 FAA drawings

- D-5001-13H Approach Lighting System - C.C. Regulator Substation - Moving Coil Type - Conduit Layout and Pad Details
- D-5205-1 Approach Lighting Substation - Power and Control Unit No. 1 - Layout, Lighting, and Dimensions.
- D-5205-2 Approach Lighting Substation - Power and Control Unit No. 1 - Wiring Diagram
- D-5205-3 Approach Lighting Substation - Constant Current Regulator Unit No. 2 - Layout, Lighting, and Dimensions
- D-5205-4 Approach Lighting Substation - Constant Current Regulator Unit No. 2 - Wiring Diagram
- C-5208 Approach Lighting Substation - Passageway Between Units 1 and 2 - Construction Details
- C-4676 Warning Sign
- C-4850 High Voltage Sign
- B-21216-H Standard Nameplate

(Minor changes in the arrangement and spacing of components, in wiring, fabrication, and construction of this unit as shown on Drawings D-5205-1, D-5205-2, D-5205-3, and C-5208 may be made as required to meet the operating and/or performance requirements of this specification).

2.2. Military and Federal publications.- The following military and Federal publications of the issues in effect on date of the invitation for bids or request for proposals, form a part of this specification.

2.2.1 Military specifications

FAA-STD-012a Paint Systems for Equipment

MIL-C-704 Treatment and Painting of Materials

MIL-C-26500 Connectors, General Purpose, Electrical, Miniature, Circular

MIL-E-5558 Enamel, Wrinkle-Finish for Aircraft Use

2.2.2 Military standard

MIL-STD-470 Maintainability Program Requirements

2.2.3 Federal specification

TT-E-489 Enamel

2.2.4 Federal standard

Fed. Std. 595 Colors

2.3 Other publications.- The following publications, of the issue in effect on the date of the invitation for bids or request for proposals, form a part of this specification.

2.3.1 American National Standards Institute (ANSI) Publications standards

C-37 Switchgear

C-57 American Standards for Transformers, Regulators and Reactors

2.3.2 National Electrical Manufacturer Association (NEMA) standard

Standards for Power Switchgear Assemblies

2.3.3 National Board of Fire Underwriters Standard

NEPA No. 70 National Electrical Code

2.3.4 Occupational Safety and Health Act

National Standards Established by Occupational Safety and Health Act (OSHA)

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(Copies of this specification and other applicable FAA documents may be obtained from the Contracting Officer in the office issuing the invitation for bids or request for proposals. The requests should fully identify material desired, i.e., standard, drawing, specification, and amendment numbers and dates. Request should cite the invitation for bids, request for proposal, or contract involved or other use to be made of the requested material).

(Request for copies of Military specifications should be addressed to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120).

(Information on obtaining copies of Federal specifications and standards may be obtained from General Services Administration office in Washington, D. C.; Atlanta; Auburn, Washington; Boston; Chicago; Denver; Kansas City, Missouri; New York; San Francisco; and Seattle).

(Information on obtaining ANSI Standards will be provided by the American National Standards Institute, 70 East 45th Street, New York, N. Y., and on obtaining the National Electrical Code will be provided by the National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts, 02110).

3. REQUIREMENTS

3.1 Materials.- Materials shall be as specified herein. When materials are used that are not specifically designated, they shall be in accordance with the best industrial standards and practices for this type equipment. All metals shall be protected against corrosion.

3.2 Workmanship.- Workmanship shall be in accordance with the highest grade commercial practice covering this type of work.

3.3 Design and construction

3.3.1 General.- The power switchgear and control unit assembly shall be of the outdoor type, constructed to comprise in one integral unit all of the equipment functionally necessary as shown on Drawing No. D-5205-1, -2, and as may be needed to fulfill all requirements of this specification. The design shall be such that components are grouped as shown on Drawing No. D-5205-1. Exact location of components and clearances shall be the responsibility of the manufacturer. Connection cables and cable cross-overs shall be kept to a minimum. All component parts shall be factory installed and wired, and all field connections shall be limited to the connections of incoming and/or outgoing power and control cables, and interconnection on power and control cables between this unit and the regulator unit Specifications FAA-1147b or FAA-1148b. It shall be designed such that the low voltage equipment is completely separated from high voltage equipment and wiring by grounded metallic barriers. All low voltage wiring passing through high voltage compartments shall be metal enclosed insofar as practical. All low voltage control panels,

distribution panelboards and metering compartments shall be of the dead front type. Metals used in the unit assembly and its components shall be selected or treated so that no corrosion will result from galvanic action. The design shall follow the maintainability design guidelines in Paragraph 5.4 of MIL-STD-470.

3.3.2 Environmental conditions.- The unit assembly shall be capable of satisfactory operation under the following environmental conditions. The remote control panel, timer and associated components are not subject to the requirements of this section.

3.3.2.1 Temperature.- Any ambient temperature from -55°C (-67°F) to plus 55°C (+131°F).

3.3.2.2 Altitude.- A pressure altitude ranging from sea level to 3,300 feet.

3.3.2.3 Humidity.- A humidity range from saturation at sea level to saturation at 3,300 feet at a temperature of +55°C (131°F).

3.3.2.4 Sand and dust.- Exposure to airborne sand particles encountered on deserts.

3.3.2.5 Salt spray.- Exposure to atmosphere containing salt laden moisture.

3.3.2.6 Weather.- Continuous outdoor operation under all weather conditions not previously specified herein.

3.3.3 Physical construction

3.3.3.1 General.- The unit shall be the metal-enclosed outdoor type, designed and manufactured in accordance with the latest applicable standards of the ANSI and NEMA (SG-5-1.018) for watertight equipment of this type.

3.3.3.1.1 Structures.- The structure shall be made of formed steel angle supports and reinforcing, with not less than No. 11 U.S. gage steel front, rear, top, and side panels, and steel flooring. Flooring in the 3 feet 6 inches by 13 feet work space shall be safety plate steel. The entire underside of the unit, including the sides and the ends of the channels, shall be given a coating of zinc chromate primer, after which a 1/8-inch thick coating of Minnesota Mining and Manufacturing Company EC-244, or equal asphalt sealing compound shall be applied to prevent corrosion.

3.3.3.1.2 Internal construction.- The unit shall contain all equipment necessary for the purpose of this specification within the space limitations shown on Drawing D-5205-1, suitably enclosed in compartmental areas. The compartments of the unit shall be securely joined together to form a continuous, in-line, watertight structure with a sloping roof as shown on Drawing D-5205-1. An internal 3 feet 6 inches minimum

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work space shall be provided, extending the entire length of the unit and shall contain no partitions or obstructions which would impede free movement along the front of the equipment compartments. Door handles and reinforcing angles on exterior walls, etc., shall not be considered as obstructions and the 3 feet 6 inches dimension shall be taken as the wall-to-wall clearance. An entrance door to Unit No. 1 and passageway to Unit No. 2 shall be provided as shown on D-5205-1 and as specified in 3.3.3.4.1. Construction of the passageway shall be as shown on Drawing C-5208.

3.3.3.1.3 Ventilation.- Ventilation shall be provided to the unit as required and shall consist of weatherproof screen-covered openings. Screened weep holes shall be provided in the floor of the unit where necessary. Screening for vents and weep holes shall be 12 by 12 mesh, copper, or bronze.

3.3.3.1.4 Unit 1 and Unit 2 interface.- This unit shall be designed to fasten securely to a separate regulator unit (#2) Specification FAA-1147b, or FAA-1148b, or both, as shown on Drawing D-5205-3 and as specified in 3.3.3.4.5. The design for attachment to Unit No. 2 shall be as shown on Drawing C-5208 and shall be such that the two units can be joined together in the field to form an integrated and complete substation which is watertight and capable of meeting all requirements of this specification; and FAA-1147b, or FAA-1148b, or both. Base channels of the same dimensional tolerance shall be selected for each of the two units (1 and 2) if necessary to assure proper mating. Thickness of undercoating on the sides of the channels, front and rear, on each unit shall be the same. The slope of the roof shall be the same on each unit and the type construction employed on each unit shall be such as to present a matched appearance when the two are joined together. When two or more units are purchased, all Units #1 shall mate with all Units #2.

3.3.3.1.5 Hardware.- No screws or bolts shall be permitted through the top surface of the unit unless welded in place. Sheet metal separators shall be installed between the high voltage, low voltage, and control compartments. The assembly shall be self-supporting and designed for installation on a level concrete pad. A minimum of three 6-inch channels shall be attached to the bottom structure of the unit for mounting purposes and with provisions for bolting to a concrete pad. Six-inch I beams may be substituted for the 6-inch channels only if used on both units. Suitable lifting hooks or eyes of adequate strength shall be provided and so located on the unit as to permit lifting and handling without tilting or distortion of the unit. The design shall permit convenient and easy connection of all external power and control cables. All components of the unit shall be rigidly mounted. Bolts used in assembling the heavy parts shall be of sufficient length that at least three full threads will show over the nut after tightening. Lock washers shall be used under all nuts.

3.3.3.1.6 Exterior.- Seams on the exterior of the substation units which are deep seated so as to trap water, or permit rusting (included

inaccessible points) shall not be permitted. Caulking compounds will not be accepted in lieu of continuous seam welds or tightly sealed, overlapping watertight joints.

3.3.3.2 Conduit entrances and cable terminations.- Floor plates, to accommodate power and control conduits extending vertically through the field installed mounting pad, shall be blank to permit field drilling as required. These plates shall, in general, be located as shown on Drawing D-5205-1. The exact location of field installed conduits will be as shown on installation Drawing D-5001-13H. The plate sizes and locations shall be such as to provide for misalignment of any and all of the conduits shown on Drawing D-5001-13H of not less than two inches in any and all directions.

3.3.3.2.1 Compartment wiring.- The series output compartment shall be provided with three high voltage series cutouts, G.E., 374065AC or equal, to accommodate six outgoing series conductors ranging in size from #8 to #6 A.W.G. Terminals and terminal boards shall be provided as designated on Drawing D-5205-2 of the proper size and voltage rating to accommodate all power and control wiring within this unit and for connection to regulator Unit No. 2. One No. 2 ground wire and terminal shall be provided in each compartment of the unit, and connected to an internal ground bus. This internal ground bus shall be a continuous copper bar or wire having a cross section equal to or greater than #2 A.W.G. wire, and shall run the entire length of the unit connecting to two exterior lugs (one on each end) for connection to the exterior station ground system. This ground bus shall not be used as a separate electrical neutral bus or instead of a separate electrical neutral bus. A conductor, separate from the internal ground bus, shall be used for neutral currents. All cable and wire terminals shall be of the pressure connector, tube type. All cable lugs shall be of the pressure, solderless type.

3.3.3.2.2 Flasher transformer - master timer compartment wireway.- A 10-inch square wireway shall be provided through the flasher transformer compartment to the master timer space above to permit termination of incoming flasher power and control cables to the terminal board in the master timer compartment. This wireway shall be solidly enclosed on all sides in the transformer compartment but shall expose the interior for wiring when the inside access panel to the transformer compartment is removed. The removable conduit floor plate specified above for this compartment shall lie within this wireway.

3.3.3.2.3 Capacitor compartment wiring.- A wireway shall also be provided in the capacitor compartment for termination of incoming series loop conduits at floor level and extension of all series cable to terminals in the compartment above. The wireway shall be solidly enclosed on all sides exposed within capacitor compartment but shall be open for wiring with exterior access plate removed. The wireway shall contain the removable plate specified above for this compartment. High voltage terminals shall be provided in the high voltage terminal

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compartment for all high voltage cable connections to Unit No. 2 and for all series cables to the field. A neutral connector shall also be provided therein for connection of the neutral between Units No. 1 and 2. No sharp corners will be permitted in wireways.

3.3.3.3 Accessibility.- All parts contained in the metal-clad housing unit shall be conveniently accessible for maintenance or replacement. No equipment shall be mounted on dead-front panels, unless the panels are hinged and can be opened a minimum of 90° swing for maximum accessibility to all components and wiring within the compartment and/or on the rear side of the hinged panels. High voltage equipment located in the rear of compartments and not accessible from the front shall be accessible from the rear by removal of external rear housing plates. All control components attached to panels where the rear is not readily accessible shall be designed for removal or replacement from the front.

3.3.3.4 Access doors and panels.- All metal parts shall be free from buckling and warping.

3.3.3.4.1 Entrance door and passageway access.- A weatherproof #11 gage steel access door, 6 feet 4 inches by 2 feet 8 inches, equipped with heavy-duty hinges of the size and thickness necessary to support the door without sag shall be incorporated in the left end of the unit (Drawing D-5205-1) for entrance to and exit from the unit. The door shall be hinged on the left side so as to permit opening back against the unit housing wall. A latch shall be provided to hold the door in this position. The door shall have provision for padlocking and shall have a three-point latch set designed to be opened from either the inside or outside. The door when in the closed and latched position shall be weatherproof. The hinges, padlock attachments, and operating handles shall be designed so as to minimize vandalism or forced entry to the substation. If hinges and attachments are mounted with screws or bolts, they shall be welded or adequately peened over inside to prohibit removal from the outside. A 6 feet 4 inches by 2 feet 8 inches door opening shall be provided in the right end of the housing as shown on Drawing No. D-5205-1 for access to passageway specified in 3.3.3.4.5 and detailed on Drawing C-5208. Bolts and boltheads shall not encroach on the headroom within the centermost 2 feet 0 inches of entrances and passageways.

3.3.3.4.2 Interior dead-front access panels and doors.- Dead-front access panels and doors shall be provided on each of the compartments where required within the unit and as shown on Drawing D-5205-1. Access doors which are used as mounts for electrical components making up the electrical system shall be grounded by a suitably flexible bonding strap between such doors and the enclosure frame.

3.3.3.4.2.1 Panels and doors.- The panels and doors shall be not less than No. 11 U.S. gage sheet steel. The doors shall be formed in one piece with rolled edge construction and they shall be hinged with either continuous piano hinges or with hinges approved by industry for similar switch gear doors and regularly used by the manufacturer for standard production line switch gear. The doors shall open with a minimum swing of 135 degrees except end doors limited in swing by compartment walls.

End doors shall swing not less than 90 degrees. Door latches shall be of the "T" handle type, either a single handle with a three-point latch or two handles each with a single point latch per door. If two latches are used they shall be separated vertically by at least one half of the door height. All hinges and latches employed shall be of the same design. The interior panel or panels covering the compartment housing connections to the regulator shall be secured with large slotted binding head screws. Other interior access panels shall be secured with chrome plated knurled thumbscrews. The thumbscrews shall have a large slotted head with recessed shoulder. The thumbscrews shall be designed to remain in place on the panel when the panel is removed and they shall be received by self aligning, self retaining type nuts retained within the structure. Screws that are received by tapped holes within the structure will not be accepted.

3.3.3.4.2.2 Key interlock system.- A key interlock system shall be provided between the oil circuit breaker and the series output compartment door as shown on Drawing D-5205-1. The function of the interlock shall be to prevent the opening of the series output compartment door until the operating handle of the oil circuit breaker has been placed in the "off" position, deenergizing the series equipment. Electrical interlocks will not be considered as meeting this requirement.

3.3.3.4.3 Outdoor rear access panels.- The outdoor rear access panels shall be provided where necessary and shall be not less than No. 11 U.S. gage steel housing plates. These plates may extend the full height of the structure and shall be the same width as the interior compartments they cover. Plates shall be assembled with threaded hexagonal headed bolts received within tapped holes within the angle iron framework of the structure or by nuts permanently positioned, and shall be spaced on a maximum of 12 inches centers. Plates shall be nonwarping and weather-proof.

3.3.3.4.4 Front and end housing panels.- Front and end housing panels other than panels previously specified in 3.3.3.4.3 shall be constructed of No. 11 minimum U.S. gage sheet steel and shall be securely attached to the framework in such a manner as to be completely weatherproof. Top edges at juncture with an overlapping roof and bottom edges joining the base shall be of such construction as to be weatherproof.

3.3.3.4.5 Passageway panels and attachments.- The right end of the unit shall have a six feet 4 inches by 2 feet 8 inches opening for access to and exit from Unit No. 2, Specification FAA-1147b, or FAA-1148b, or both. Fabrication details for passageway and method of attachment to both units shall be as shown on Drawing C-5208. The attached arrangement shall be such as to insure a proper fit of panels and connection to Unit No. 2 without minute adjustments when assembling the two units on a concrete pad. All steel parts and panels making up the passageway assembly shall be provided as shown on Drawing C-5208. The floor plate shall be safety steel plate and reinforced to prevent sag.

3.3.3.5 Equipment compartments.- Equipment compartments as hereinafter specified shall be such that all high voltage and low voltage equipment shall be located and arranged as specified in 3.3.1 as to require the minimum of space in accordance with standard practices for this type of apparatus, without sacrificing space requirements necessary for removal, repair and replacement of such equipment for maintenance purposes. All high and low voltage equipment shall be separated by barriers or screening in accordance with standard practices applicable to switchgear design. Bracket or shelf mounting of equipment may be employed where feasible, providing sufficiently rigid supports are incorporated. All meters, controls, switches, panelboards, etc., mounted on compartment front panels, shall be of the flush or semi-flush mounted type but not intermixed.

3.3.3.6 Circuitry.- The overall unit circuitry and interconnection of components shall be as shown on Drawing D-5205-2. Any additional control components shall be as shown on Drawing D-5205-2. Any additional control components and wiring required to accomplish the functions of this unit shall be provided. All terminal board connections shall be marked as shown on Drawing D-5205-2.

3.3.3.6.1 Series loop wiring and termination.- Connections shall be made from six series insulated stand-off bushings of regulator Unit No. 2 to the six bushings in Unit No. 1, thence through three series disconnect switches to six more stand-off bushings for connection of series loops to the field. Field connections to the loops shall be made to these stand-off bushings by field personnel.

3.3.3.6.2 Series circuit metering.- The series metering shall be through potential transformers (PT) and current transformers (CT) which shall be mounted in the No. 2 unit with the secondaries of the PTs and CTs connected to the ammeters and voltmeters located in the output metering compartment of Unit No. 1. Wiring between these voltmeters, ammeters, and switches shall be completed in the substation and carried to the interconnecting terminal board for field connection to the regulator Unit No. 2.

3.3.3.6.3 Unit 1 and Unit 2 interconnection.- High voltage and control connections between the Unit No. 1 and Unit No. 2 shall be as shown in dotted lines on Drawing D-5205-2.

3.3.3.6.4 Control sequence.- Control power for the Unit No. 1 shall be taken from a circuit breaker of the distribution panel compartment. For remote control of approach lights, the local control switch shall be turned to the remote position. The regulator shall then be controlled from the Remote Control Tower Panel by turning on the remote control tower switch to close the oil circuit breaker. The brightness selector switch in the Remote Control Tower Panel is turned to the desired brightness position to energize the desired D.C. brightness relays 1A through 5A. The contacts of relays 1A through 5A shall be wired to the terminal board for interconnection to the Regulator Unit No. 2 to start the proper sequence of control in the regulator unit to select

the desired brightness position. When position five is energized, the elapsed time meter should run to show the total time on position five.

3.3.3.6.4.1 Local control.- On local control the local drum switch is placed on the desired brightness step deenergizing the D.C. remote control circuits and energizing the brightness relays of Unit No. 2 at 120 V.A.C., directly from the switch contacts. Remote and local control of sequenced flashing lights will operate in a similar manner to close and open the contactor except that the control relays and local-remote switch are to be furnished by others.

3.3.3.6.4.2 Auxiliary relays.- Two auxiliary D.C. relays shall be supplied for D.C. operation from the Remote Control Tower Panel. These relays in turn shall energize power contactors for operating auxiliary loads. The contacts of these auxiliary power contactors shall be brought to a terminal block located in the control input compartment.

3.3.3.6.4.3 Monitoring.- A monitor relay and brightness position relays for the approach lights shall be provided for control from the regulator Unit No. 2 to indicate by means of indicating lamps in the tower, the load conditions and brightness position of the regulator Unit No. 2. A monitor relay and indicating lights shall also be provided for indicating operating condition of flasher system, controlled from equipment at substation to be supplied by others. The flasher control wires and flasher monitor wires shall be interconnected between the remote control terminal board and the terminal board in the flasher control compartment.

3.3.3.6.4.4 Warning buzzer.- The warning buzzer in the remote control panel shall be connected to sound off when (1) approach light monitor lights go out, (2) flasher monitor lights go out, (3) when 15 minute time cycle on Step 5 position (Approach Lights) is nearing completion.

3.3.3.7 Painting.- Rough edges and burrs shall be removed from all surfaces. All surfaces shall be suitably prepared for painting and sprayed with one coat of rust-resistant primer surfacer and dried. When thoroughly dry, all surfaces of the unit shall be painted with one base and one finish coat of insignia white in accordance with Federal Specification TT-E-489 for air drying enamel. Color shall be insignia white No. 17875, Federal Standard 595.

3.3.4 Electrical characteristics.- This unit shall have the characteristics specified herein and shall consist of all electrical components having the characteristics specified herein and as necessary to the proper operation.

3.3.4.1 Rating.- The unit shall be rated 175 KVA, three-phase, 60 cycle 2400/4160 volts and together with its associated regulator Unit No. 2 shall be capable of supplying three 20 ampere series loops each with a 50 KW incandescent lamp load through S/S 20/20 amp. transformers, a 10 KVA 120/240V power supply for the station operating transformer and a 15 KVA 240/480 volt power supply for a condenser

discharge sequenced flashing light system. It shall be designed to operate from a three-phase, four-wire, 2400/4160 volt (+5%), 60 cycle input power supply. The neutral conductor and all connections thereto shall be conspicuously identified throughout. Where cable is used for neutral connections use a white 600V wire. All equipment and circuitry for the input power supply and the 20 ampere series circuits, unless otherwise specified, shall be of the 5KV insulation class at maximum altitude of 3,300 feet.

3.3.4.2 Electrical components.- The unit assembly shall consist of all electrical components as shown on Drawings D-5205-1 and D-5205-2 and as specified herein. Necessary hardware and other devices to make a complete assembly shall be added as required.

3.3.4.2.1 Cutouts.- One oil fused cutout shall be installed in the 2.4 KV tap to the 15 KVA flasher transformer, and one such cutout for the 10 KVA control power transformer. Three spare fuse links shall be furnished for each of these cutouts. Each oil fuse cutout shall have a minimum interrupting capacity of 5,000 A. All live terminals of cutouts and high voltage wiring thereto shall be isolated from operating handles by solid metallic raceways or barriers.

3.3.4.2.2 Metering requirements.- Input and output metering equipment shall be incorporated in the No. 1 unit design. All metering equipment except PTs and CTs, shall be installed in a compartment which is completely isolated from the high voltage compartments of the units by solid metallic barriers. The meters shall be installed on hinged "dead front" panels. Space shall be provided within the compartment behind bolted access panels for the installation of all required transformers, H.V. wiring and other equipment associated with the metering equipment except series output CTs and PTs which are in Regulator Unit No. 2. All meters used in the metering compartment shall be of the one percent accuracy class 4-1/4 inch diameter, concentric scale, switchboard type. All meters shall have AC movements. All ammeters shall have individual series test blocks in the circuits for checking meter accuracy. Test blocks shall be mounted on the dead front panel as shown on Drawing D-5205-1.

3.3.4.2.2.1 Input metering requirements.- One three-phase 2-1/2 element kilowatt meter shall be furnished in this compartment and shall have a scale range from zero to 200 KW. Each scale division shall be 5 KW or less. One voltmeter reading from zero to 3,000 volts with a 150 volt movement shall be supplied. Each scale division shall be 100 volts or less. A switch having "off-1-2-3" positions shall be furnished and wired so as to selectively read phase to ground for each phase selected and have an "off" position. A nameplate located above the meters reading "Input Metering" shall be provided. Potential transformers shall have a ratio of 20:1 and shall be fused. Fuses shall have sufficient ratings to safely interrupt the circuit on all internal faults including those at the secondary terminals. Current transformers shall have a ratio of 25:5. The ratio error of instrument transformers shall not exceed 1% for the connected burden.

3.3.4.2.2.2 Output metering requirements.- One voltmeter of the same characteristics as the one supplied in the input metering compartment shall be provided. An instrument switch having "Off--1--2--3" positions shall be furnished and wired so as to selectively read output voltages across each output series loop. The voltmeter shall work from a potential transformer having a ratio of 20:1. Three ammeters each having a zero to 25 ampere scale with one-half ampere divisions shall be provided for current indication of series output loops. These shall operate from current transformers having a ratio of 25:5. These instruments shall be energized from current and potential transformers located in regulator Unit No. 2. An elapsed time meter, indicating type, G.E. No. 909X85 or equal shall be furnished and wired to indicate total elapsed time the substation is operated at the 20 ampere level. This meter shall total up to at least 1,000 hours and indicate total time in hours and one-tenth hours. After one thousand hours, it shall start back at zero hours. This meter shall have a caption stating "Total Elapsed Time on Maximum Output." A nameplate above the meters reading "Output Metering" shall be provided. The elapsed time meter shall be for 120 volt operation.

3.3.4.2.3 Lightning arresters.- Primary distribution type lightning arresters shall be furnished for the protection of the incoming 2400/4160V cable and for each leg of each output 20 ampere series circuit cable. Suitable low voltage protectors of the thyrite or gas tube spark gap type shall be provided for each conductor of the control cable at both the substation assembly and at the remote control point. Suitably rated low voltage arresters shall also be incorporated to protect all low voltage auxiliary power circuits and the telephone circuit. All arresters at the substation unit shall be installed within the assembly enclosure and as close to incoming and outgoing cable terminals as space and good design permit. The arresters at the remote control station shall be incorporated in the timer cabinet with connections at the terminal block for the incoming control cable. In the case of the low voltage control cable lightning arresters, a common ground bus shall be furnished for all such arresters with one pressure type ground connector for attachment to station ground (#6 wire).

3.3.4.2.4 Oil circuit breaker.- A three-pole, solenoid operated remote controlled oil circuit breaker (O.C.B.) similar and equal to General Electric Company, Type FK-143, shall be supplied for remotely controlling the high voltage supply to Regulator Unit No. 2 and the flasher transformer. The breaker shall have a minimum interrupting capacity at 5,000 A. The oil circuit breaker shall include an oil gauge and provision for removing test samples of oil from the circuit breaker tank. The oil gauge shall be so positioned that it can be easily read from the entrance service aisle of the substation. The design of the circuit breaker tank shall be such that oil samples may be taken from the lower four inches of the circuit breaker tank without disassembling the circuit breaker. The O.C.B. equipment shall include an operation counter to record up to 99,999 operations.

3.3.4.2.4.1 Solenoid operating mechanism.- The solenoid operating mechanism shall be mounted integrally with the breaker. It shall be equipped with

a d-c closing coil energized from a full-wave silicon rectifier which shall be furnished with the equipment. The rectifier shall be connected to the 230 volt secondary of the 10 KVA control power transformer through one molded case breaker of the a-c distribution panelboard. The rectifier shall have a current rating adequate to supply the d-c closing requirements of the breaker over a range of 190-250 volts a-c, in accordance with ASA standards. Protection shall be provided for the rectifier to prevent damage in case of an overload on the closing coil.

3.3.4.2.4.2 Interlocks and auxiliary functions.- The solenoid mechanism shall be furnished with the required (four-stage minimum) number of auxiliary switches to accomplish the specified control, indication and interlocking functions. A key interlock shall be furnished so that access to the series cutouts can only be accomplished when its breaker is open.

3.3.4.2.4.3 Trip coils.- The solenoid mechanism shall be provided with one 230 V a-c potential trip coil to be used for normal tripping operations from the control circuits. In addition, there shall be supplied three instantaneous current trip coils with adjustable calibrations from 15 to 27 ampere. These current coils shall be connected in the secondary of the current transformers, operating to trip open the breaker when the current exceeds the calibration.

3.3.4.2.4.4 OCB tank.- Each breaker shall be supplied with the necessary quantity of oil. Breaker tanks shall be equipped with gaskets properly seated to make the assembly oil-tight for all operations within the breaker rating.

3.3.4.2.4.5 Manual operation.- An emergency operating handle, to permit closing the breaker for maintenance purposes shall be furnished with each assembly.

3.3.4.2.4.6 Terminals.- The six breaker studs shall be equipped with terminals for making connections. Studs and terminals shall be insulated by taping.

3.3.4.2.4.7 OCB compartment.- The breaker and its operating mechanism shall be mounted on rigid structured steel supports, entirely enclosed and separated from the operating aisle by steel barriers. Provisions shall be made by means of removable covers to obtain access to the breaker and its mechanism for maintenance purposes, preferably from the service aisle. However, as an alternate, the oil circuit breaker may be accessible for servicing from the rear by removal of one of the external bolted rear panels. This panel shall not exceed five feet in height or 90 pounds in weight and be adequately gasketed, to make it weather-tight, with a type of gasket which will not require replacement in less than 25 normal servicing operations. This panel shall be fitted with flush weather-tight hand holes for removal and replacement positioning. In the event the panel cannot be limited in weight to 90 pounds, it shall be replaced by a hinged door fitted with gasketing and flush hand holes, as above, and interlock keyed to the interlock on the oil circuit breaker.

3.3.4.2.4.8 Tank lifter.- Provision shall be included for attaching a windlass-type tank lifter for lowering the breaker tanks. The tank lifter (1) shall be furnished with each assembly.

3.3.4.2.5 Series disconnects.- Three high voltage (H.V.) porcelain series disconnects similar or equal to G.E. No. 3740654AC shall be provided to receive the series circuit cables from Regulator Unit No. 2 and for connection to outgoing series cables.

3.3.4.2.6 Capacitors.- Indoor-type capacitors shall be provided for use on the input power circuit to provide the required power factor correction. The indicating fuses shall be of current limiting type and properly rated to withstand inrush current when energized and to protect the capacitors from ruptured cases in the event of internal fault. Adequate cooling shall be provided. Electrolytic capacitors are not acceptable in power circuits. Single bushing capacitors may be used if desired. Electrolytic capacitors are permitted in control circuits.

3.3.4.2.7 Auxiliary and control power transformer.- Power for the low voltage auxiliary power distribution circuit and control power for the substation shall be obtained from a 10 KVA, 2400-240/120 volt, 60 hertz conventional-type oil insulated self-cooled (OISC) transformer located as shown on Drawing No. D-5205-1. The transformer shall have high voltage taps, 2-2 1/2% above and 2-2 1/2% below. The primary tap for this transformer shall be made at a suitable connection point between the input terminals and the oil circuit breaker as shown on D-5205-2. The transformer and all associated high voltage wiring shall be within a metallic enclosure, inaccessible except when designated access panels are removed. Transformer protection and disconnection shall be provided by an oil fused cutout in the input compartment as specified in 3.3.4.2.1.

3.3.4.2.8 Flashing light transformer.- Power for the low voltage flashing light system shall be provided by a 15 KVA, 2400-240/480 volt, 60 hertz conventional-type OISC transformer located as shown on Drawing D-5205-1. This transformer shall have high voltage taps 2-2 1/2% above and 2-2 1/2% below the rated input voltage. Wiring and circuit protection shall be as shown on the wiring diagram on Drawing D-5205-2. Oil fused cutouts shall be as specified in 3.3.4.2.1.

3.3.4.2.9 Distribution panelboard.- A flush mounted, circuit breaker, distribution panelboard bearing the Underwriter's label shall be provided in the control compartment for low voltage auxiliary and power and control requirements. The panel shall have a main 70 ampere, two-pole circuit breaker. The panel shall contain ten 20 ampere trip, single pole and 3-30 A double pole quick-make, quick-break thermal magnetic air circuit breakers with the bottom four single pole breakers so arranged that they may be bridged for two-pole operation. All spare circuits on distribution panelboard shall be wired to a terminal board in the L.V. and control compartment and appropriately marked as such.

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3.3.4.2.10 Flasher circuit breaker.- A flush mounted, air circuit breaker, bearing the Underwriter's label, shall be provided in the flasher compartment for flasher control power from the flasher transformer. The breaker shall be a two-pole device rated 50 ampere 600 volts and shall be located as shown on Drawing D-5205-1.

3.3.4.2.11 Flasher master timer.- Provision shall be made for the installation by others of a 40 inches by 24 inches by 8 inches Master Timer and Monitor Cabinet with mounting dimensions as shown on Drawing D-5205-1. Steel supports with bolt holes to the dimensions shown on the drawing shall be provided. Contained in this cabinet will be all components of the flasher master timer auxiliary monitoring equipment, the flasher local control and monitor panel. Connections from the master timer to the terminal board to be provided in the flasher compartment will be made by others. The power input to the flasher master timer shall be deenergized when the ALS switch on the remote control panel is in the off position even though the SFL switch may be in the on position. With the ALS switch in the on position, turning the SFL switch to the off position shall also deenergize the power to the flasher master timer.

3.3.4.2.11.1 Flasher contactor.- A contactor similar or equal to Allen Bradley Company, Bulletin 702, enclosed type, two-pole NEMA size 2, 50 ampere shall be furnished and installed within the flasher control compartment and connected to the output terminals of the circuit breaker specified in 3.3.4.3.1.

3.3.4.2.12 Relays, auxiliary contactors and miscellaneous control devices.- The various relays and auxiliary contactors employed in the control system for this unit shall conform to the following requirements:

- (a) D.C. Relays: 120 V D.C. Coil
Contacts 120V A.C. (Min)
Five ampere minimum continuous 200,000 operations minimum. These relays shall be plug-in type enclosed in polystyrene dust cover and shall be similar and equal to Potter & Brumfield Type KRP.

High quality octal sockets shall be provided for these relays conforming to applicable MIL specifications for such equipment.

- (b) A.C. Aux. #1: NEMA size one relay to operate.
Aux. #2: 12 A, incandescent lamp load.
120 V.A.C. coil.

- (c) P.L. Aux. 120 V.A.C. Coil.
and Load 5 A, 120 V, Contacts.
Monitor Aux.

All auxiliary relays and contactors except the P.L. auxiliary and load

monitor auxiliary relays shall be equipped with dust-tight covers. Miscellaneous Control Devices - rating as required and equipped with tight covers where electrical contacts are incorporated.

3.3.4.2.13 Rectifier protective circuits.- Special protective devices shall be incorporated in the circuitry to protect the rectifiers and relays against switching and lightning surges. The circuit shall provide protection against voltages up to 2,000 volts. A demonstration of the effectiveness of this protection will be required at the time of the prototype inspection.

3.3.4.3 Control.- A control system shall be furnished with the unit which shall provide positive and instantaneous control either from a remote point or locally at the assembly. The control shall provide for turning approach lights on and off, five positions of brightness and the necessary indicating lights and monitoring equipment as specified in 3.3.4.3.1.1. It shall also provide for the control of flashers as shown on Drawing D-5205-2. The design shall be such that the incoming supply to the substation will not be interrupted during any of the control operations, except when deenergizing the assembly. Power for performing all control operations shall be furnished by the 10 KVA auxiliary and control power transformer. All control wiring and components shall be as shown on wiring Diagram Drawing D-5205-2.

3.3.4.3.1 Remote control.- The remote control shall be in accordance with Drawing D-5205-2 and, in addition, shall contain such equipment that all required operations including two spare circuits can be realized using the required number of conductors of a 26 pair, No. 19, armored, shielded control cable at distances up to 20,000 feet from the regulator substation assembly. All terminal positions on terminal boards shall be labeled as shown on Drawing D-5205-2. If required for varying control cable lengths, compensating devices shall be provided. Such devices shall be calibrated in terms of the one-way circuit length (in feet) between the remote control station and the substation.

3.3.4.3.1.1 Brightness control.- When operated and switched as specified above either locally or remotely, the D.C. brightness control auxiliary relays shall not overlap more than one second nor have an interval between successive operations of more than two cycles.

3.3.4.3.1.2 Auxiliary control.- The two auxiliary remote control circuits shall remain operative at all times regardless of whether on local or remote control.

3.3.4.3.1.3 Flasher control.- A flasher monitoring circuit or circuits shall be provided as shown on Drawing D-5205-2 between the control tower and the flasher master timer terminal board in substation Unit No. 1. The remote control tower panel shall be provided with a flasher switch and monitor indication lights as shown on the drawings and as specified below.

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3.3.4.3.1.4 Remote control panel.- A control panel for use in the control tower or the remote control point shall be supplied with each Unit No. 1. The panel shall be of the flush mounting type having all parts enclosed in a metal housing suitable for indoor use. The panel shall be as small as possible and the enclosing cabinet shall be not more than 8 inches wide by 10 inches long by 6 inches in depth. An additional overhang of 3/8-inch on each side of the cabinet shall be provided for flush mounting on a control desk. A 3/16-inch mounting hole shall be located in each corner of the overhang. The panel shall be of stainless steel, not less than 1/10-inch thick. The housing shall be of steel or aluminum. The panel and housing shall be cleaned and processed, except for exposed hardware in accordance with the applicable requirements of MIL-C-704. Painting shall be in accordance with FAA-STD-012a, System FS-(3). The top and bottom surfaces of the top panel shall be painted with brown enamel, color Number 30117 of Federal Standard 595 with a smooth matte finish coat of baked enamel. The interior and exterior surfaces of the panel housing shall be finished with baked gray enamel, color Number 16314, Federal Standard 595. All lettering and designations shall be engraved or etched and finished in white. Parts requiring mounting screws shall be supported from a subpanel. No mounting screws, other than those required to mount the panel, shall be installed on the face of the panel. Four, panhead, stainless steel, No. 8 wood screws, one inch long shall be furnished with each panel for mounting by others.

3.3.4.3.1.5 Remote control panel equipment.- Control equipment located on the panel and installed in the enclosure shall include, but shall not be limited to the following:

- (a) Approach Light Brightness Selector Switch, five-position, rotary.
- (b) Timer Reset Switch, push-type, momentary contact.
- (c) Panel Light Intensity Control - this dimming device, with normal number of indicating lights operating shall reduce voltage at the lamps from 12 volts to any and all values between nine and 12 volts. All indicating lights installed on the remote control panel shall be connected through this device except the red lights indicating malfunction or ALS Step Five time limit. The red indicator lights shall not be provided with means for dimming.
- (d) Approach Light Switch - this switch shall be four-pole, double throw toggle type, designed to remotely control the substation.
- (e) Flasher Switch - this switch shall be two-pole, single throw toggle type.
- (f) Auxiliary Switches - two single pole, single throw toggle type switches shall be provided on the panel for control of obstruction lights and/or other auxiliary electrical loads in the vicinity of the substation.

- (g) Buzzer - a heavy-duty buzzer shall be installed within the control panel housing. The buzzer shall operate upon failure of either the flasher system, or the approach light system and, in addition, shall serve as a warning in connection with the brightness step, timer as specified in 3.3.4.3.3.2.
- (h) Trouble Switches - two single pole, double throw toggle type switches shall be installed on the panel to silence the buzzer, leaving the red trouble lights in operation.
- (i) A MIL-C-26500 type box mounting connector shall be installed in the bottom of the panel housing. Flexible stranded conductors shall be installed and cabled between this connector and all panel mounted electrical parts, in accordance with wiring diagram, Drawing D-5205-2. The cable conductors shall be adequate in length to permit removal of the panel and subpanel from the panel housing for servicing of parts. The connectors shall contain not less than 32 pin contacts for #16 AWG or smaller conductors. A mating cable connector with socket contacts, screw coupling and cable clamp shall be furnished with the box mounting connector for field application.

3.3.4.3.1.6 Remote control panel indicating lamps.- The panel shall be complete with all equipment indicated above and in addition, contain the following dual (Parallel connected) indicated lamps;

- (a) Dual green indicator lights for the series approach light circuits to indicate when lighted that the substation assembly is energized, under remote control, and supplying the proper number of connected lamps as determined by the monitoring adjustments described in FAA-1147b and FAA-1148b for Unit No. 2. A drop in load below that established by the monitor system will cause the lamps to go out. Simultaneously, dual red lights, Item 4 below, shall be energized along with an audible alarm. (This one set of green lights provides simultaneous indication for all three loops).
- (b) Dual green indicator lights which will react to the intelligence signals transmitted from the flasher master timer cabinet at the substation, in such manner as to light continuously when flashers are functioning properly and to go out when upon failure of any one or more sequenced flashing lights in the system to flash. Simultaneously, dual red lights, Item 5 below, shall be energized along with an audible alarm.
- (c) Dual amber indicator lights adjacent to each of Positions 1 through 5 of the brightness selector switch shall indicate that the regulators have responded to the signal transmitted from the selector switch to deliver an output current corresponding to the brightness position selected. When the selector switch is set opposite Position 5, the amber lights opposite this step shall be energized. If left in this position as long

as 14½ minutes an audible alarm (buzzer) will sound. The design shall permit the alarm to be silenced by operating a reset switch, specified in 3.3.4.3.1.5(b) by moving the selector switch to Position 4, or after 30 seconds the regulator will automatically step back to Position 4. When Position 4 is selected manually or automatically the Position 5 lights shall be extinguished and Position 4 lights energized. The automatic change of steps will not change the operation position of the selector switch.

- (d) Dual red indicator lights shall be provided to indicate malfunction of the approach light system.
- (e) Dual red indicator lights shall be provided to indicate malfunction of the sequenced flashing light system.
- (f) Green, red, and amber indicating lamps on the remote control panel are not to be energized when the control assembly is under local control.
- (g) The indicator lamps, holders, and lenses shall be as follows:

Indicator Panel Lamps.- Indicator panel lamps shall be of the 12 volt switchboard type similar and equal to those manufactured by General Electric Company T2, 12 volt, .09-.11A slide base.

Indicator Panel Lamp Jacks.- Indicator panel jacks shall be similar and equal to Dial Light Company Catalog No. 37428-11.

Indicator Lamp Color.- All lamps shall show their respective colors when lit and when extinguished shall appear to be black.

Indicator Panel Lamp Caps.- Indicator panel lamps caps shall be the switchboard type, similar and equal to Dial Light Company, No. 37-11. Lamp caps shall be provided with red, green, and amber lenses as required.

3.3.4.3.1.7 Remote control panel indicating lamp operation.- The combined operation of the ALS control switch, the ALS trouble switch, the dual green lights and the dual red lights associated with these switches and the buzzer shall be as follows: After the ALS control switch is placed in the "on" position the green indicator lights shall be energized to indicate proper operation. If trouble develops resulting in a change in the load or the inability of any regulator to supply its connected load, the green indicator lights will go out and the red indicator lights and the buzzer will be energized. By moving the trouble switch from the normal to the trouble position, the buzzer will be silenced, but the red indicators will continue to operate. After the trouble is corrected and the substation resumes normal operation the red indicator lights will be automatically deenergized and the green indicator lights and the buzzer will be energized. To silence the buzzer, it will be

necessary to move the trouble switch to the normal position; the buzzer will be silenced. The monitor system for the flasher system shall be identical in operation to that of the ALS.

3.3.4.3.1.8 Remote control panel equipment layout.- The position of equipment on the remote control panel shall be as follows: Across the bottom of the panel in a horizontal row there shall be four toggle switches, identical in appearance to the panel face. These switches shall be labeled left to right APPROACH LIGHTS - AUX. 1 - AUX. 2 - FLASHERS. In addition, "on" and "off" positions of each switch shall be marked. The brightness selector switch shall be mounted directly above the auxiliary switches and on the vertical centerline of the panel. The switch shall be provided with a large pointer type knob. Brightness positions 1 through 5 shall be marked around the arc inscribed by the pointer knob. These positions shall coincide with the detent positions of the switch. The dual amber position indicator lights shall be installed at each position on a radius approximately $\frac{1}{2}$ -inch greater than that of the position numbers. The inscription APPROACH LIGHT BRIGHTNESS SELECTOR SWITCH shall appear directly below the switch. The dual green indicator lights shall be installed directly above the ALS and the flasher control switches. The four remaining control devices shall be installed in a horizontal line above the selector switch and its associated indicator lights. The following inscriptions shall appear under these devices left to right, ALS TROUBLE SWITCH - TIMER RESET - PANEL LIGHT INTENSITY - SFL TROUBLE SWITCH. Dual red indicator lights shall be installed directly above the ALS and the SFL trouble switches. The panel light intensity control shall be provided with a small pointer type knob. The arc inscribed by the end of the pointer shall be marked NIGHT at the left end, corresponding to minimum intensity and DAY on the right end, corresponding to maximum intensity. The trouble switches shall be marked N at the left position of the handle and T at the right position, representing "normal" and "trouble" positions.

3.3.4.3.2 Local control.- Suitable arrangements shall be made to permit selection of the various output series current steps of the substation assembly by local control independent of the remote control D.C. relays as shown on D-5205-2. Local control shall be attained using A.C. only and a seven position switch, with the switch positions marked and connected to give the following operations:

- Position 1. Remote control panel connected into the circuit with local control circuits open.
- Position 2. Off-remote and local control circuits open and control assembly oil switch open.
- Position 3. Local control for Position 1 (8.3A series output); remote control circuits open.
- Position 4. Local control for Position 2 (9.9A series output); remote control circuits open.
- Position 5. Local control for Position 3 (12.1A series output); remote control circuits open.

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Position 6. Local control for Position 4 (15.3A series output); remote control circuits open.

Position 7. Local control for Position 5 (20A series output); remote control circuits open.

Dual red bull's eyes shall be provided in the local control cabinet to light up when on local control (including local off position). Dual green lights shall also be incorporated on the local control panel to provide the same monitoring information as the green lights on the tower panel, except that these lights shall function both on local and remote control.

3.3.4.3.3 Approach light timer.- A timer mechanism, with the necessary terminal strips, assembled in an indoor surface mounted cabinet shall be furnished with each unit for installation in the control tower. A dust tight, overall cover shall be provided on the timer cabinet designed for maximum accessibility to all equipment within, and for removal and replacement with cabinet mounted vertically on a wall. Cover may be hinged, or of the bolted-on type. If of the bolted type, not more than six bolts shall be used for convenience in servicing. The exterior of the timer cabinet is to be finished in grey-green enamel. The timer cabinet shall contain the control components and be wired as shown on Drawing D-5205-2. The inside surface of the timer cabinet cover shall contain a connection wiring diagram of all equipment and wiring therein, all equipment and wiring of remote control panel and terminal block connections to the substation.

3.3.4.3.3.1 Timer operation.- The timing circuit shall operate in the following manner: When the brightness selector switch of the remote control panel above is placed in Position 5, the timing mechanism shall begin the timing cycle and shall automatically reduce the current to the next lower value after a 15 minute interval. The timing delay mechanism shall be of the automatic resetting type and shall be so arranged that at any time during its cycle of operation it can be reset for an additional 15 minute period by merely operating a momentary contact push button on the remote panel.

3.3.4.3.3.2 Timer operating sequence.- The operating sequence of the timing relay mechanism shall be as follows: When the brightness selector switch is moved to the maximum current position, the timer shall be energized. After 14½ minutes, the warning buzzer in the remote control panel shall be energized. Thirty seconds later, or at the conclusion of a total period of 15 minutes, the timer shall automatically reduce the current to the next lowest current level and deenergize the warning buzzer. The volume of the warning buzzer shall be adjustable to suit requirements of tower personnel.

3.3.4.4 Interior lights and convenience outlets.- Interior lighting and convenience outlets shall be as shown on the wiring diagram Drawing D-5205-1. A continuous fluorescent strip light, the nearest commercial length to that of the compartment, shall be installed lengthwise along the ceiling of the work space of the compartment located to adequately

light the equipment panels. The outlets shown on Drawing D-5205-1 may be changed in number, or relocated, or both, to best fulfill this requirement.

One 120 volt grounding type convenience outlet with slot for portable equipment grounding lead shall be installed as shown on the wiring diagram of Drawing D-5205-1. A 240 volt, 20 ampere, 3 pole, twistlock receptacle shall be provided as shown for plugging in an electric heater. No. 12 RHW wiring shall be installed in $\frac{1}{2}$ -inch galvanized heavy wall rigid steel conduits and circuits run to the distribution panelboard as required. A single pole toggle switch for the light shall be provided as shown.

3.3.4.4.1 Strip heater.- Installed within each of four compartmented areas at a central location and accessible for maintenance shall be installed a strip heater of 500 watt capacity for elimination of moisture. These shall be wired as shown on the interior wiring diagram Drawing D-5205-1. The 500 watt heaters may be divided into two 250 watt heaters for each compartment for improved heat distribution.

3.3.4.5 Electrical wiring.- High voltage wiring between connections shall be adequately supported with abrasion protective bushings, or encased in metal raceways or conduits. Any open wiring through bulkheads and metal panels shall be made using bushings free from sharp edges. Sharp bends in insulated wires shall not be permitted. All wires connected to screw type terminals shall be properly lugged. All low voltage power and control wiring shall be terminated on suitable terminal blocks and shall be readily accessible from the interior work space of the unit. All internal connections may be made on terminal blocks of type General Electric Company, Model #614C788 or equal. The pressure connector tube type shall be used as now specified for all external connections. Terminal blocks shall be marked as shown on drawings. When insulation is removed from wire for the purpose of making connections, care shall be taken to see that the copper conductor is not nicked or cut in any way. In the event it becomes necessary to run low voltage or control wires into high voltage compartments (such as CT and PT leads, etc.), they shall be isolated insofar as practical from the high voltage wiring by grounded metallic or suitably insulated wireways. Joints in high voltage and neutral conductor shall be kept to an absolute minimum and all H.V. wiring and connections shall be insulated with flame resistant material in amount to effect full voltage insulation in accordance with industry standards. All wiring in the system shall comply with National Electrical Code.

3.3.4.6 Marking and stenciling.- All equipment component (relays, meters, switches, etc.), shall be clearly identified by nameplates or bold permanent type stencils throughout. Identification markings shall agree with designations on diagrams and in parts lists. Phasing shall be shown in like manner for all such equipment and circuitry throughout the substation. All control wires shall be provided with end identifications in the form of a plastic band around the wire with identifying markings permanently stamped thereon, or with the markings permanently

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stamped onto the wire itself. All power cable shall be similarly marked, except that a permanently stamped rigid laminate tag may be attached near the cable ends in lieu of the above. The terminating points for all wires and cables at terminal blocks or equipment terminals shall be clearly and permanently identified corresponding to the circuit and terminal designations as shown on wiring diagrams. The internal wiring of components such as relays, contactors, and breakers, etc., need not be marked but all wiring connecting thereto shall be. Sizes of all fuses shall be stenciled adjacent to fuse blocks on mountings.

3.3.4.6.1 High voltage warning sign.- A high voltage warning sign bearing the inscription "Danger High Voltage - Deenergize High Voltage to Substation Before Removing Panels" shall be stenciled across the center of the back of Unit No. 1 and also inside Unit No. 1, to the bolted covers in front of compartment 1A, 1B, and 1C. Letters shall be at least 1 inch high.

3.3.4.7 Telephone set.- A telephone set with two telephones, handsets and five-bar generators similar to Kellogg 1100 series, shall be provided with the No. 1 unit. One telephone shall be installed where shown on Drawing D-5205-1 and wired to the terminal board in the low voltage and control output compartment for connection to the remote control cable. The other telephone shall be packed and shipped with the No. 1 unit for installation in the control tower by others. A connection diagram, complete with all terminal markings (for substation terminal boards and telephone units) shall be furnished for the telephone set. If the equipment is suitable for two-wire or three-wire operation, both methods shall be shown. Installation instructions and recommended location for battery (not to be furnished) shall also be included.

3.3.4.8 Folding test table.- A portable folding metal table shall be provided in Unit No. 1 for holding instruments while testing. The table top shall be 2 feet by 1 foot-8 inches and shall have four legs. When in the open position, the table shall stand 30 inches high from the floor. The legs shall be fitted with rubber feet to prevent slipping. A wall bracket shall be provided on the interior wall of Unit No. 1 for holding the table in place when not in use and when in the folded position.

3.3.4.9 Instruction book holder.- A flat metal box shall be provided on the interior wall of Unit No. 1 for the reception of instruction books. The top of the box shall be open for easy deposit and removal of these books. Box dimensions shall be determined by the manufacturer in accordance with the dimensions of instruction book manuscript which the manufacturer will furnish.

3.4 Nameplates.- A stainless steel or brass nameplate, permanently and legibly filled in with the following information shall be securely attached to each substation unit. A suitable reference shall be made to the instruction booklet, which is to be furnished with each assembly. A wiring diagram of the power circuits shall be added showing the

connections to all H.V. terminals. The nameplate shall be made up as follows and shall be mounted on the access panels immediately below the local control compartment.

Constant Current Regulator Substation
Power & Control Unit No. 1
Type CCRS-3 (UNIT 1)
Specification FAA-1146b
Rating Three-phase 2400/4160V, 60 Cycles 175 KVA
FAA Contract No. Quantity
Manufacturer's Part No.
Manufacturer's Name or Trade Mark
Instruction Book No.
Federal Stock No.

A nameplate shall be attached to the remote panel with the following information:

Constant Current Regulator Substation
Type CCRS-3
Remote Control Panel
Specification FAA-1146b
FAA Contract No. Quantity
Manufacturer's Part No.
Manufacturer's Name or Trade Mark
Instruction Book No.
Federal Stock No.

A nameplate shall be attached to the timer cabinet with the following information:

Constant Current Regulator Substation
Type CCRS-3
Timer Cabinet
Specification FAA-1146b
FAA Contract No. Quantity
Manufacturer's Part No.
Manufacturer's Name or Trade Mark
Instruction Book No.
Federal Stock No.

3.5 Warning signs.- "Danger" signs in accordance with Drawing C-4676 and a "No Trespassing" sign in accordance with C-4850 shall be attached to the substation assembly with stainless steel screws in the locations shown on Drawing D-5205-1.

3.6 Instruction book manuscripts.- "Instruction book manuscripts shall be furnished in accordance with Specification FAA-D-2494/1 and /2."

3.6.1 Instruction books.- The government will reproduce and prepare instruction books from the manuscript copy (3.5) and furnish copies to the contractor for shipment with the equipment. Two instruction books shall be included with each set of equipment comprising a system.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- The contractor shall provide and maintain a quality control program which fulfills the requirements of FAA-STD-013, Quality Control Program Requirements. The contractor's quality control program shall be a scheduled and disciplined plan of events integrating all necessary inspections and tests required to substantiate product quality during design, development, purchasing, subcontracting manufacture, fabrication, processes, assembly, acceptance, packaging, and shipping. The contractor shall perform or have performed the inspections and tests required to substantiate product requirements and shall also perform or have performed all inspection and tests otherwise required by the contract.

4.2 Tests.- The prototype of the complete substation (Units No. 1 and 2) shall be inspected and tested at one location for conformance with all requirements under the contract. High voltage supply power of sufficient capacity and voltage shall be available as well as adequate resistance and 300 watt and 500 watt, 20/20 A series/series transformer loads to permit variation from no load to full load, and open secondary tests on transformers as required for testing monitor effectiveness. The two prototype units (No. 1 and 2) shall be fully interconnected both physically and electrically for the operational tests. The testing may be performed one phase at a time if desired.

4.2.1 Design qualification tests.- The following tests shall be conducted on the preproduction sample to prove compliance with the requirements of this specification.

4.2.1.1 Examination of product.- The assembly shall be thoroughly examined to check conformance with all basic design and physical requirements as specified in 3.1, 3.2, 3.3, 3.4, and 3.5.

4.2.1.2 Environmental tests.- Tests of the entire unit to prove performance under the environmental conditions specified in 3.3.2 will not be required except as specified in 4.2.1.2.1; however, the manufacturer shall furnish a certification that the unit will give satisfactory performance under all environmental conditions specified.

4.2.1.2.1 Rain test.- The rain test shall be conducted on the complete substation assembly (No. 1 and 2 units (3.3.3.1)) fully connected physically. The unit shall be checked for watertightness (within the meaning of NEMA definition SG-5-1.018) by simulating a driving rain on all exterior joints, doors, bolted panels and on the enclosures in general. This test shall be in accordance with Underwriter's Bulletin #23 entitled, "Rain Test of Electrical Equipment, Method and Apparatus." The requirements of this paragraph apply to any throat connection provided between the constant current regulators and the unit compartment, as well as to the compartment structure.

4.2.1.3 Dielectric test.- The assembly shall be given an applied 60 cycle A.C. voltage test for one minute on the following circuits and at the voltage specified.

High Voltage Equipment and Power Wiring (Includes Series Output Equipment and Wiring)	19 KV
Low Voltage Equipment and Power Wiring	1.5 KV
Control Equipment and Control Wiring (Including Timer Cabinet and Lightning Arrester Panel, but excluding Remote Panel)	1.0 KV
(Components incapable of taking this high voltage may be disconnected before the test).	
Remote Control Panel	250 V

4.2.1.4 Electrical performance test.- The assembly shall be energized at 2400/4160V (+5%) for normal operation from the remote control panel with a simulated 20,000 foot, 26 pair, #19 control cable between the assembly and the remote panel. The test procedure shall be such as to prove conformance with all operating requirements specified in 3.3.3.4.2, 3.3.3.6, 3.3.4.1, 3.3.4.2.4, 3.3.4.2.13, 3.3.4.3, and 3.3.4.5. This test may be performed one phase at a time if desired.

4.2.1.5 Standard impulse test.- This test shall be performed, unless otherwise specified, as described in ANSI Standards for Transformers, Regulators and Reactors, and ANSI Standards for switchgear for the specified insulation class of the equipment. Impulse tests may be performed on the individual electrical components 3.3.4.2 before final assembly of the unit or on the completed assembly at the discretion of the contractor. The impulse tests may be conducted at a location other than that designated for the prototype inspection; however, the equipment shall be adequate for performing all impulse tests required under the referenced ASA standards for this type equipment, including the chopped wave tests. Photographic facilities shall also be available for taking pictures of the impulse test shots including visual observation of the applied waves.

4.2.2 Standard acceptance tests of production units.- Each production unit shall be subjected to the same tests prescribed above for the preproduction sample except the rain test and impulse test. Acceptance testing on all production units shall likewise be performed at one location having high voltage power supply and load facilities as required for the preproduction model. Each No. 1 unit shall be connected electrically and mechanically with a No. 2 unit for operational testing as specified in 4.2.1.4 of each unit specification. Unit 1 and 2 shall be physically connected to test proper alignment.

5. PREPARATION FOR DELIVERY

5.1 Application.- The packaging, packing, and marking requirements specified herein apply only to direct purchases by or direct shipments to the Government.

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5.2 Packaging.- Each power and control unit shall be commercially packaged. Containers shall conform to the requirements of Consolidated Freight Classification Rules in effect at the time of shipment. All relays and other internal parts shall be suitably blocked to prevent damage. The unit shall be shipped complete with oil in all components which require oil.

5.3 Packing.- The unit shall be packed for domestic shipment unless otherwise specified. Exterior containers, insofar as possible, shall be uniform in size and shape, and shall contain one substation unit and accessories. Containers shall conform to the requirements of Consolidated Freight Classification Rules in effect at the time of shipment and shall be designed to insure acceptance by common carrier for safe transportation at the lowest rate to the point of delivery.

The units are to be shipped separately and the openings to the walkway shall be securely closed for watertight storage and shipment. Wood covers, not less than ½-inch thick, shall be used to close these openings. All doors to be secured in closed position for shipment. Skids for moving and shipping shall be of hardwood.

5.4 Marking.- Containers shall be durably and legibly marked with the following information:

Constant Current Regulator Substation
 Power & Control Unit No. 1 - Type CCRS-3 (Unit 1)
 Specification FAA-1146b Quantity Purchased _____
 Manufacturer's Part No. _____
 FAA Contract No. _____
 Manufacturer's Name or Trade Mark _____
 Federal Stock No. _____

Metal tags bearing the serial number of the substation shall be fastened to the door handle of the No. 1 unit and also to the plywood panel covering the passageway entrance to Unit No. 2 so as to be conspicuous from outside the crates.

6. NOTES

6.1 Options.- In using this specification purchasing officers should take special care to exercise all options. Options to be considered are as follows:

<u>Paragraph</u>	<u>Description</u>
4.3.1.2.1	Delete rain test if not required.
4.3.1.5	Delete impulse test if not required.
4.3.2	Specify if test reports not required.
5.3	Packing, if other than for domestic shipment.

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